pages, so that the whole paper would make a considerable volume dealing with temperatures in the Alpine regions of Austria.

M. D'ABBADIE begs us to state that the earth-tremors observed in his apparatus (NATURE, vol. xxxii. p. 568) about two miles north of the Spanish frontier coincided with the many earthquakes in the south of Spain. There were no such phenomena in Egypt.

THE additions to the Zoological Society's Gardens during the past week include a Bonnet Monkey (*Macacus sinicus* ♂) from India, presented by Mr. L. C. Phillips; a Ring-tailed Coati (*Nasua rufa* ♂) from South America, presented by Lieut. W. F. Tunnard, R.N.; a Black Wallaby (*Halmaturus ualabatus* ♂) from South Australia, presented by Mr. R. E. Wootton Isaacson; a Javan Cat (*Felis javanensis*) from Java, presented by Capt. T. H. Franks; a Puma (*Felis concolor* ♂) from South America, presented by M. Rodolfo Aranz; two West Indian Rails (*Aramides cayennensis*) from Brazil, presented by Mr. J. C. Fraser; a Levaillant's Amazon (*Chrysotis levaillanti*) from Mexico, presented by Mr. H. D. Astley, F.Z.S.; a Silver Pheasant (*Euplocamus nycthemerus*) from China, presented by Mrs. James; three Robben Island Snakes (*Coronella phocarum*), a Hoary Snake (*Coronella cana*), a —— Elaps (*Elaps hygiæ*), a Reddish Pentonyx (*Pelomedusa subrufa*) from South Africa, seven Geometrical Tortoises (*Testudo geometrica*) from the Orange River, South Africa, presented by the Rev. G. H. R. Fisk, C.M.Z.S.; a Rose-crested Cockatoo (*Cacatua moluccensis*) from Moluccas, deposited; a Blue and Yellow Macaw (*Ara ararauna*) from Trinidad, received in exchange; eight Summer Ducks (*Œx sponsa*, 4 ♂ 4 ♀) from North America, purchased; a Bennett's Wallaby (*Halmaturus bennetti* ♀), born in the Gardens.

## ASTRONOMICAL PHENOMENA FOR THE WEEK, 1885, OCTOBER 18–24

(FOR the reckoning of time the civil day, commencing at Greenwich mean midnight, counting the hours on to 24, is here employed.)

*At Greenwich on October 18*

Sun rises, 6h. 31m.; souths, 11h. 45m. 9·9s.; sets, 16h. 59m.; decl. on meridian, 9° 47′ S.: Sidereal Time at Sunset, 18h. 48m.

Moon (two days after First Quarter) rises, 14h. 51m.; souths, 20h. 0m.; sets, 1h. 17m.*; decl. on meridian, 10° 27′ S.

| Planet | Rises h. m. | Souths h. m. | Sets h. m. | Decl. on meridian ° ′ |
|---|---|---|---|---|
| Mercury | 6 37 | 11 51 | 17 5 | 9 43 S. |
| Venus | 10 37 | 14 30 | 18 23 | 23 26 S. |
| Mars | 0 6 | 7 38 | 15 10 | 16 38 N. |
| Jupiter | 3 35 | 9 54 | 16 13 | 3 5 N. |
| Saturn | 20 41* | 4 49 | 12 57 | 22 17 N. |

* Indicates that the rising is that of the preceding and the setting that of the following day.

*Phenomena of Jupiter's Satellites*

| Oct. | h. m | | Oct. | h. m. | |
|---|---|---|---|---|---|
| 21 | 4 32 | I. tr. ing. | 22 | 4 10 | I. occ. reap. |

The Phenomena of Jupiter's Satellites are such as are visible at Greenwich.

| Oct. | h. | |
|---|---|---|
| 20 | 0 | Saturn at least distance from the Sun. |
| 20 | 13 | Saturn stationary. |

## GEOGRAPHICAL NOTES

THE work done by Lieut. Wissmann in his exploration of the Kassai River, the great southern tributary of the Congo, is second in importance only to the discovery of the Congo itself. It will seriously modify the conjectural geography of that part of Africa. He found the river to be of immense volume, and navigable from its junction with the Lulua. He found the Sankuru and the Lubilash to be one river, which, instead of flowing northwards to the Congo, turns westwards, and joins the Kassai. As it approaches the Congo Kassai receives the great Koango, and enters the main river by the Kwamouth, after receiving the water of Lake Leopold. Thus the river which on Stanley's last map joins the Congo west of Stanley Falls cannot be the Lubilash, and, moreover, must be of no great length. This discovery of Lieut. Wissmann, along with that of the Mobangi by Mr. Grenfell, greatly increases the navigable waterway of the Congo system.

THE September number of *Petermann's Mittheilungen* has for its principal article the first part of an account of Paulitschke and Hardegger's journey to Harar, by Dr. Paulitschke. It is accompanied by a map of the districts traversed. The present instalment describes the circumstances under which the journey was undertaken, the preparations at Zeila, where the English consul was able to put the travellers in friendly communication with Abu Bakr, the Governor of Zeila, who gave them the most important help, and the details of the journey as far as Bussa, on the frontier of the Northern Gallas country. Dr. Schinz asks the question whether Namaqua-Land or Nama-Land is correct, and decides in favour of the latter. "Namaqua" is a Dutch corruption; the term "Nama" is applied to Hottentots in general, without any distinction of sex; "namaqua" is properly "namagu" or "namaga," the nominative and dative plural of "nama"; "qua" is therefore doubly wrong as a suffix, and Namaland is the proper term. M. Rabot writes on the Stor Börgefjeld in Nordland in Norway, and the usual literary and geographical news brings the number to a conclusion.

THE last number (Band xxviii. No. 29) of the *Mittheilungen* of the Geographical Society of Vienna contains a paper on the ethnic members of the western Somali and north-eastern Galla tribes, by Dr. Paulitschke, accompanied by a map; six letters from Dr. Lenz on his Congo expedition, and the first part of a paper by Herr Jülg on the erosive action of the sea on coasts; the bibliography of Africa for the last half year, and the usual notices of geographical works conclude the number.

M. BRAN DE SAINT POL-LIAS, who was sent on a scientific mission to Tonquin and Java, returned to France towards the close of September. He brought back with him numerous specimens of the flora and fauna of the districts through which he travelled.

THE chief geographical societies in Germany have resolved to erect a monument to the late Dr. Nachtigal on Cape Palmas, where he lies buried. It is intended to have it so large that it will serve as a landmark to seamen.

THE Godeffroy Museum at Hamburg, illustrative of the natural history of the South Sea Islands, has been sold to the Ethnographical Museum of Leipsic.

## THE GREAT OCEAN BASINS[1]

I.

THE ancients, down to the time of Aristotle—and most of them for a long time afterwards—regarded the earth as a great plain surrounded on all sides by the mighty, deep, gently-flowing stream of the ocean.

In the geography of the Homeric age there was not supposed to be any communication between the Mediterranean and this all-encircling ocean river. When, in consequence of the excursions of the Phœnicians, the communication through the Pillars of Hercules became known, ideas respecting the outer sea gradually changed. At first, curiously enough, the Atlantic Ocean was regarded as muddy, shallow, and little agitated by the winds—a belief apparently associated with the supposed subsidence of the legendary island of Atlantis. The world, as known to the ancients down to about 300 years before Christ, is represented in this map of Hecatæus.

There seems to be no doubt that the spherical form of the earth was known to some philosophers even before the time of Aristotle—the proof that the earth is a sphere being indeed easy to minds that had received a mathematical training—but these have been few in all ages, and an idea so directly opposed to the apparent evidence of the senses could only be expected to win its way with difficulty. Indeed, at the present day the majority of even educated people are unable to give any reason for their belief that the earth is a sphere, other than that navigators are now in the habit of sailing around it.

[1] Lecture delivered at the Aberdeen meeting of the British Association by Mr. John Murray, Director of the *Challenger* Reports.

However, we find that Erathosthenes, Posidonius, and other learned Greeks, who flourished between one and two centuries before our era, were in possession of ideas concerning the figure and position of the terrestrial globe which do not differ materially from those of the modern geographer. They had considerable knowledge of the great wide sea, a clear perception of the diurnal recurrence of the tides, of their monthly cycles of variation, and correctly ascribed these changes to the influence of the moon. They speculated on the circumnavigation of the globe, and thus anticipated by many centuries the project of Columbus of sailing direct from Spain to the Indies.

During the century immediately preceding the Christian era, and during the dark and middle ages, there was a large acquisition of information with respect to the superficial extent of the ocean. But, when we look back on the history of knowledge concerning our planet, there is to be found no parallel to the impression produced in men's minds and conceptions by the discovery of America, and the circumnavigation of the world, a few years later, by Magellan and Drake. The influence of these events and the great ideas associated with them, can be traced throughout the literature of the Elizabethan period; Shakespeare appears to have had the mental picture of the great, solid, floating globe continually before him. His spirit seemed

"... . blown with restless violence round about
The pendant world."

To the great mass of people the circumnavigation of the globe was the practical demonstration that the earth was swung in space, supported alone by some unseen power; it was the conclusive proof of its globular form—a fact which must be regarded as the fundamental principle of all scientific geography.

The rage for geographical exploration which set in after the discovery of America brought the phenomena of the ocean into greater prominence, but the science of the sea can hardly be said to have commenced till the seventeenth century, when Hooke and Boyle undertook their experiments as to the depth of the sea and the composition of ocean water; and several naturalists gave descriptions of the animals and plants inhabiting the shallow waters surrounding the land. During the eighteenth century there was again a large acquisition of knowledge concerning the ocean, for the navigator was busy with the study of the winds, currents, and tides; while the two Rosses with other explorers and scientific men made most praiseworthy endeavours to investigate the greater depths of the sea during the first half of the present century.

The vast abysmal regions of the great ocean basins, however, lay all scientifically unexplored, when about twenty years ago their systematic examination was undertaken by expeditions sent forth by our own country and by the Governments of the United States, Germany, Italy, France, and Norway.

It is not easy to estimate the relative importance of the events of one's own time, yet in all probability the historians of the reign of Victoria will point to the recent discoveries in the great oceans as the most important events of the century with respect to the acquisition of natural knowledge, as among the most brilliant conquests of man in his struggle with nature, and doubtless they will be able to trace the effect of these discoveries on the literature and on the philosophic conceptions of our age. A mantle of mystery and ignorance has been cleared away from the eleven-sixteenths of the earth's surface covered by the ocean, and in its place we have much definite and accurate knowledge of the depths of the sea. The last of the great outlines showing the surface features of our globe have been boldly sketched; the foundations of a more complete and scientific physiography of the earth's surface have been firmly laid down.

This evening we will endeavour to pass in review some of the chief phenomena of the great ocean basins, and attempt to bring before you some of the more important results arrived at by the many distinguished men who have been engaged in oceanographical researches during recent years.

If it be remembered that the greatest depth of the ocean is only about five miles, and that the height of the highest mountain is likewise about five miles above the level of the sea, while the globe itself has a diameter of 8000 miles, the comparative insignificance of all the surface inequalities of the earth is at once forced on our attention. A circle 66 feet in diameter having on its surface a depression of one inch; or a globe one foot in diameter, with a groove on its surface one-sixtieth of an inch in depth, would represent on a true scale the greatest inequality, of mountain height and ocean deep, on the surface of the earth. Misconceptions often arise, and erroneous conclusions are frequently arrived at when these proportions are not rigidly borne in mind. But, unimportant as these surface features may appear when viewed with reference to the diameter of the earth, or to the superficial area of an ocean several thousand miles in extent, still to the geologist and physical geographer the elevations and depressions, foldings and dislocations, vertical and lateral, which form these inequalities are truly gigantic, immense, profound; and the more they are studied the more do they appear to be the result of changes taking place in a very definite and orderly manner in the course of the earth's developmental history.

Allow me to direct your attention to the maps representing hemispheres of the earth drawn in equal surface projection. The continental land of the world is coloured black, the abyssmal regions are coloured red, and between these two there is a border or transitional area which is uncoloured.

You will observe that the dark-coloured masses of continental land are, at some one point, more or less closely connected with similar masses; there is usually a place where adjacent masses are not separated by oceans of very great depth. A traveller might almost journey from any one point in these regions to any other without once losing sight of land. If an exception must be made to this statement it is in the case of New Zealand and the Antarctic Continent, for the *Challenger's* dredgings, which brought up masses of schist, gneiss, granite, sandstone, and compact limestone along the borders of the ice-barrier, show beyond all doubt that there is a mass of continental land at the south pole, but, since it is buried beneath perpetual snow, its exact extent is a matter of conjecture.

The surfaces of the continents are everywhere cut into cliff and gorge, mountain and valley, and are continually undergoing a process of disintegration. Water, frost, ice, sudden changes of temperature, are ever tearing the solid rocks to pieces, rivers are transporting the fragments down to the ocean, or carrying away the solid earth in solution; the bulk of this material is deposited in the areas bordering the continents—the uncoloured areas on the maps—there to form rocks which may once again become dry land. Sooner or later the whole of the continents would in this way be reduced below the level of the waves, were not other forces at work producing elevation. Such forces there are, and they are probably more potent than the disintegrating and transporting forces, since there are many reasons for believing that there is now more dry land than at any other period of the earth's history.

The continents have an average height of about 900 feet above the level of the sea; they may be regarded as elevated plateaus occupying five-sixteenths of the earth's surface.

The abysmal regions of the earth, represented by the red colour on the maps, occupy eight-sixteenths, or one-half of the earth's surface, and have an average depth of three miles beneath the surface of the waves. The greatest depths in the Pacific are to the south and east of Japan, where there are abysses of over five miles; and in the Atlantic the greatest depth is to the north of the Virgin Islands, where there is a depression of a little over four miles.

From all we yet know of these abysmal areas they have not a diversity of peak, gorge, mountain, and valley comparable to those which are met with on land; they are fundamentally areas of deposition. It is true that the close soundings of telegraph engineers appear to show that in some cases there may be steep cliffs in the shallower depths of the ocean in volcanic areas; yet the general aspect of the abysmal regions must be that of vast undulating plains, interrupted here and there by huge volcanic cones, with slopes at a very low angle. When these cones rise above the surface they form volcanic oceanic islands. When they rise nearly to the surface they are, in the tropics, often capped by coral atolls; but many of them are far beneath the waves and are covered by a white mantle of carbonate of lime—the dead shells and skeletons of pelagic and deep-sea organisms.

The land of the oceanic islands is of small extent and differs widely in the nature of the rocks, as well as in the character of the terrestrial and marine fauna and flora, from the continents and continental islands. There has not been found in the abysmal areas any land made up of gneisses, schists, sandstones, or compact limestones; nor have fragments of these sedimentary formations been found in the erupted rocks of the volcanic islands, though they are frequent in the volcanic eruptions on the continental areas.

We may, indeed, compare the oceanic islands to the fresh and salt water lakes scattered over the surface of the continents and

cut off from direct communication with the ocean. These lakes differ as much from the waters of the ocean as do the oceanic islands from the land of the continents.

The surface of the earth may then be divided into three great regions—the abysmal area, occupying, so to speak, the bottom of the basins, covering one-half of the earth's surface; a border region occupying, so to speak, the sides of the basins, covering three-sixteenths of the earth's surface; and lastly, the continents which cover five-sixteenths of the earth's surface. The average height of the elevated plateaux of the continents above the submerged plains forming the abyssmal regions is fully three miles.

When we pass to a consideration of the water of the ocean, which fills these great hollows of the earth, it is essential to take account of the superincumbent atmospheric ocean, which everywhere rests on its surface, for the composition of the ocean water, the currents, the distribution of salinity, density, temperature, and even that of deep-sea deposits, are largely determined by the movements of the atmosphere.

One of the most important parts played by the ocean in the economy of the globe is to bring about a more equable distribution of temperature by the winds which blow from it over the land and by means of the oceanic currents that are originated and maintained by the winds.

From the smallness of the *daily* variation of the temperature of the surface of the sea, which are shown by the *Challenger* observations, as discussed by Mr. Buchan, not to exceed 1° F., as compared with the large daily variation on land, there result directly the land and sea breezes with all their beneficial consequences. Similarly from the small *yearly* variation of the temperature of the sea, as compared with the very large variation of the temperature of the land surfaces of the globe, result those great annual changes of the prevailing winds—the most important of which, with respect to widespread climatic effects, is the summer monsoon of the Europeo-Asiatic continent.

But the most important, as well as the most direct, effect of the unequal distribution of temperature over the surfaces of the oceans and continents, is an unequal distribution of atmospheric pressure varying more or less with season. On the one hand, in a particular season we see a portion of the earth's surface with atmospheric pressure much less than in surrounding regions, and as long as the low pressure is maintained the winds from the regions all around continue to blow inwards upon it, bearing with them the temperatures and humidities of the regions from which they have come. On the other hand there are other parts of the earth's surface with atmospheric pressure much higher than in adjoining regions, and, as this state of things continues with little variation throughout the year, the winds blow out in all directions towards surrounding regions. Of this two illustrations may be given.

During winter months atmospheric pressure is much less in the North Atlantic about Iceland than it is all round, and towards this area of low pressure the winds from the surrounding continents blow vorticosely, thus determining the winter climates of the more important countries of the world. Over Canada and the United States the winds are north and north-westerly, by which the rigours of winter are intensified; but in Western Europe the prevailing winds are south-westerly, and, as these winds bring with them the warmth and moisture of the Atlantic, the winter climates of Western Europe contrast strongly, latitude for latitude, with those of the eastern states of America.

Again, pressure is higher in the Atlantic between the north of Africa and America than it is all round, and out of this anticyclonic area of high pressure observations show that the winds blow in all directions towards surrounding regions where pressure is less. To the westward of North Africa the prevailing winds are northerly and north-westerly, but on the south side of this anticyclonic region the winds are easterly, and on the west the winds are southerly.

Owing to these very different winds, and the oceanic currents to which they give rise, the temperature of the sea is much higher off the coasts of Florida than it is off the coasts of Africa in the same latitudes. The effect of these differences is recognisable in the distribution of marine life and coral reefs, and, consequently, of the deposits at the bottom of the sea.

Since over this anticyclonic area, and similar ones in the South Atlantic, North Pacific, and in a less marked degree in the South Pacific, atmospheric pressure remains high throughout the year, notwithstanding the outflow of wind all around from them, it follows that aërial upper currents must flow towards these high pressure regions accompanied by a slow downward movement of the air through their central portions. Now, as observations show that in such circumstances the sky is clear, the air dry, the rainfall small, and the evaporation large, it follows that over these parts of the great oceans, where atmospheric pressure is higher than all around, the rainfall is very far from being sufficient in amount to make good the loss arising from evaporation—a consideration which has important bearings on the difficult question of oceanic circulation.

As in these anticyclonic regions in the great oceans there is opened up a direct communication between the upper regions of the atmosphere and the surface of the sea, by means of the descending aërial currents, it is interesting to ask whether this fact may not have some connection with the volcanic and cosmic dust found in the same regions in the deep-sea deposits; especially is this interesting in connection with recent speculations as to the presence of these substances in the higher regions of the atmosphere.

In thus indicating the positions of the high-pressure areas, and of the winds that blow out from and around them over the great oceans, we have at the same time traced the courses of the great oceanic currents and the positions of the Sargasso seas, for the winds everywhere determine and control the movements of the surface waters.

The moisture taken up from the sea surface by the winds—leaving the water salter than before—is borne to the land and condensed on the mountain-slopes. Eventually this water gathers off the land, passes by rivulet, stream, and river down again to the ocean, bearing along with it a burden of earthy matters in solution. In this manner the ocean has most probably become salt in the course of ages. The water of the ocean now contains, it is almost certain, a portion of every element in solution. Many of these are present in exceedingly minute traces. They are detected either in the sea water or the evaporated-down residue by spectrum analysis; in the copper of ships' bottoms, which have withdrawn them by chemical decomposition; or, again, in the ashes of sea-weeds and marine animals, which, during life, exert a selective influence upon the surrounding water.

(A diagram was exhibited showing the average composition of sea salt.) The individual salts present in sea water are, of course, constantly interchanging their metals and acid radicals, so that it is impossible to say authoritatively what is the precise amount of the respective chlorides and sulphates of sodium, potassium, calcium, and magnesium actually present. But it has been shown by hundreds of laborious and most delicate experiments that the actual ratio of acids and bases in sea salts—that is, the ratio of the constituents of sea salts—*is constant* in waters from all depths, with one very significant exception—that of lime—which is present in slightly greater proportion in deep water.

The total amount of dissolved salts in the ocean would, it is calculated, if extracted, form a pavement 170 feet thick over the entire sea-bed, and of this amount $1\frac{1}{4}$ inches would be composed of pure carbon, chiefly present as carbonic acid in the carbonates.

On account of the constancy in its composition the determination of any one of the constituents of sea salt—chlorine, for instance—gives the datum for calculating the salinity—that is, the proportion of total salts to the water in which they are dissolved; though determinations of this nature are more conveniently made by observations of density by means of the hydrometer. (A map was exhibited on which Mr. Buchanan has shown the results of his laborious investigations in this direction.) An examination of this shows that the surface water of the ocean is freshest—that is, contains the least salt—at the poles and in the equatorial belt of calms. In the east of the Indian Ocean a change of the monsoons brings about a great change in the salinity of the surface water. The centres of the great systems of oceanic currents produced by the trade winds are the areas of highest salinity in the open ocean; yet here the water is not so salt as in some enclosed seas situated in areas of great evaporation, as the Mediterranean, and especially the Red Sea and Persian Gulf, where the saltest water is found and where a regular circulation is kept up by the outward flow of the denser water. The salinity of the deeper waters is considerably below the average at the surface in the open ocean, especially in the Atlantic.

In the equatorial regions the surface water of the ocean has occasionally a temperature of 85° or 86° F., and the normal temperature in tropical and sub-tropical regions ranges from 60° to 80°. This warm water is, however, a relatively thin stratum

on the surface, the great mass of the ocean consisting of cold water—water of 45°, 40°, and of even a much lower temperature. At a little over half a mile of depth in the tropics the water has a temperature of 40°, and at the bottom it is still colder—ice-cold indeed. The ooze which is dredged from the bottom beneath the burning sun of the equator is so cold that the hand cannot be held in it for any time without great discomfort.

In the open ocean the temperature usually decreases with the depth, the coldest water being found at the bottom; but sometimes there are limited areas where the temperature remains uniform for a mile or half a mile above the bottom. This has been shown to depend on the existence of barriers to free circulation, which exist on the floor of the ocean, and cause in a measure a resemblance to the conditions which are so marked in many partially enclosed seas, shut off by submarine barriers from general oceanic circulation, where the temperature is uniform, it may be, from a few fathoms below the surface to the bottom—for instance, in the Mediterranean and Seas of the Malayan Archipelago.

The low temperature of deep ocean water was acquired at the surface in high latitudes, chiefly in the high latitudes of the southern hemisphere. The salt warm water of the tropical regions, which is driven in relatively rapid currents along the eastern shores of South America, Africa, and Australia by the action of the prevailing winds, on reaching a southern latitude of 50° or 55° sinks on being cooled, and spreads over the floor of the ocean. A similar circulation takes place in the northern hemisphere, though modified in many ways by the peculiar configuration of the land: for instance, it is almost certain that the cold water at a temperature of 30° F., which occupies the deeper part of the Norwegian Sea beyond the Wyville-Thomson Ridge, is the dense surface water of the Atlantic, which becomes cold and sinks as it passes northward in the extension of the Gulf Stream. Again, the relatively low temperature found on the eastern coasts of Africa and America seems largely due to the cold deep water which is drawn up to supply the place of the warm surface water driven forward by the trade winds.

While surface currents, both warm and cold, have at times considerable velocities, there is no evidence that rapid currents exist anywhere in the great deeps, on the contrary, the movements must be extremely slow and massive in character; the only exception seems to be on the crests of some ridges at moderate depths between volcanic islands or other similarly situated places.

Through the constant circulation in the ocean the gases of the atmosphere, which are everywhere absorbed at the surface of the sea according to the known laws of gas absorption, are borne down and thus enable myriads of living organisms to carry on their existence at all depths. The nitrogen remains at all times and places nearly constant, but frequently the proportion of oxygen is much reduced in deep water, owing to the processes of oxidation and respiration which are there going on.

The absorbed carbonic acid plays a most important and intricate *rôle* in the economy of the ocean, owing to its tendency to reduce normal carbonate of lime and magnesia to solution in the form of bicarbonate; and to the rapid interchanges to which it is subject in consequence of vital processes. It probably receives large additions from the bottom of the ocean, as an after-product of volcanic eruptions, and through the respiration of animals.

It is often supposed that hydrochemical actions go on with much greater activity in the deep sea where there may be a pressure of four or five tons on the square inch, but, while it would be convenient to assume it, there is no sufficient evidence that such is the case. The disintegrations, decompositions, and depositions which take place in the deposits are all similar to those which take place in shallow water or on land, and any chemical peculiarities occurring in inorganic or organic substances in great depths are probably due chiefly to the low temperature, almost perfect stillness, and the absence of light: for, although it may be admitted that some rays descend to much greater depths in the sea than is usually supposed, yet we must at present believe that none of them reach the greatest depths. The absorbed gases are probably but little affected by the great pressure of the superincumbent water, for in this connection it should be remembered that water is but little compressible; any substance which will sink to the bottom of a tumbler of water will in time sink to the bottom of the deepest ocean; this is true at least for all substances which are more compressible than water itself. The compressibility of water cannot, however, be neglected in oceanographical questions. In very great depths the lower layers are considerably compressed; for instance, in an ocean five miles deep, were the action of gravity suddenly to cease, the water would rise about 500 feet above its present level from expansion, a height sufficient to submerge nearly all the habitable land of the globe.

It remains to mention the investigations, which have recently been made, as to the change of level of the ocean, owing to the attraction of the masses of continental or other land—such, for instance, as that of the Himalayas for the water of the ocean to the south, by which the level of the Southern Indian Ocean is lowered some hundred feet; the bearing of this on the apparent elevation or submergence of land along coast-lines is evident, for the level of the sea, to which we refer all heights and depths, cannot be regarded as much more stable than the solid land itself.

(*To be continued.*)

## *NEW PROCESS OF LIQUEFYING OXYGEN*[1]

LIQUID ethylene, the preparation and use of which I have already explained, shows, at its boiling-point under the pressure of the atmosphere, a temperature of at least −103° C., only some 10° from the critical temperature of oxygen (−113° C.). It is understood how in the expansion of compressed and cooled

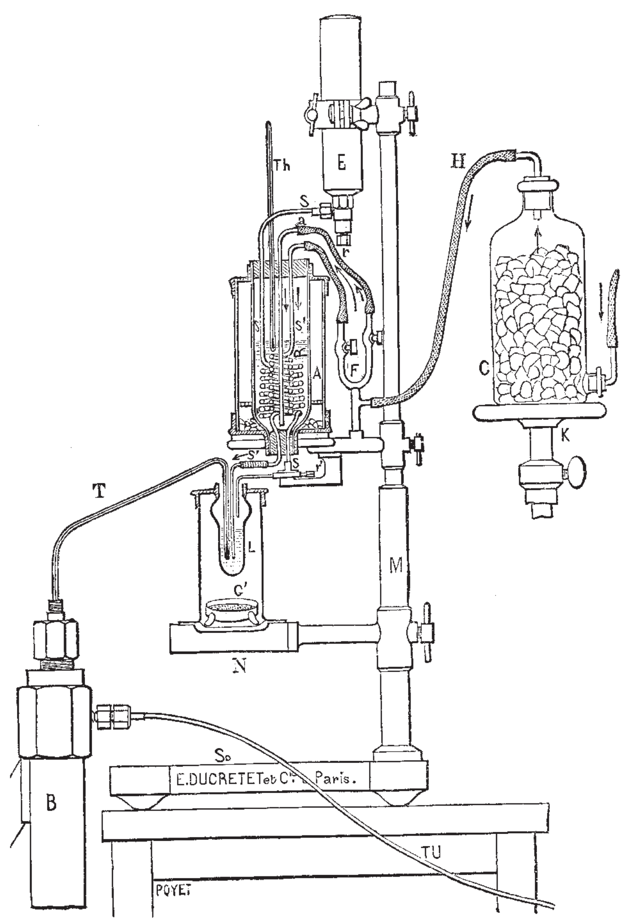


Fig. 1.

oxygen in the boiling ethylene the lowering of the temperature resulting from the expansion enabled me to establish "a tumultuous ebullition continuing an appreciable time." In

[1] From the *Journal de Physique*. By M. L. Cailletet. The illustrations have been kindly lent by MM. Ducretet et Cie, the manufacturers of M. Cailletet's apparatus.